Space Weather Technical Forecast

Issued on Tuesday, 11 October 2022 at 13:21 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares. Active electron Fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with a few M-class flares observed. The largest flare during the period, was an M3.9 flare peaking at 11/0842 UTC from AR3112 in the northwest quadrant. Awaiting coronagraph imagery for any potential coronal mass ejection (CME). There was another M-class flare, also originating from AR3112 peaking at M1.5 at 11/1052 UTC. There was another M-class flare from AR3112, which was observed at 10/1628 UTC. There are currently five numbered sunspot regions on the visible disc. AR3112 remains the largest and most complex region on the disk, though has lost its delta configuration due to the splitting on the intermediate spot region. To its north, AR3116 continued to see some fading to its trailing portion. In the east AR3118 we have seen some decay of its trailing portion, with emergence of small leading spots. AR3119 has just crossed into the western hemisphere but hasn't produced any significant flares. AR3120 remains a small uni-polar spot. Around 09/2300 UTC a filament eruption was seen from the southeast quadrant, this has been analysed as missing to the south and behind Earth. Finally, during the early hours a dimming was detected in AIA 211 in the central southwestern quadrant, possibly related to a filament lift off. Imagery has been analysed and does not support an Earth-directed component.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1 has declined from elevated levels to slightly elevated values around 400 km/s as Earth exits a coronal hole high speed stream. The phi angle was mostly positive (away from the Sun). The solar wind density has been below average values. The IMF was weak throughout, with a peak near or below 5nT. The north-south component has been mostly weak, with peaks of +3 and -4nT observed. Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, has been at Background levels.
High energy electron flux (greater than 2MeV) has been at Moderate to High levels, peaking at 3590 pfu at 10/1625 UTC. The associated 24-hour fluence has been above the Active (1e8 integrated pfu) threshold throughout. The 10/2359 UTC observation was 1.54e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low to Moderate initially. This may reduce through the period as current sunspots look to simplify slightly, but with Moderate still possible particularly as one or more new active regions are likely to rotate over the eastern limb onto the visible disk. None of the more noteworthy groups on the disc are expected to leave the western limb in the next four days, though AR3112 will be close by the end of day 4 (14th Oct).

Solar Wind / Geomagnetic Activity: There are no major Earth-directed CMEs in the forecast, however the 07/0730 UTC filament eruption CME may pass close to the Earth late on day 1 or early day 2 (11th or 12th), giving some very slight peripheral influences. Otherwise, ongoing fast

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winds, most probably from CH29/+ and perhaps CH31/+, are likely to continue to ease through day 1 (11th), likely approaching background by day 2 (12th October). Some enhancement is possible at times due to possible glancing CME effects. However, a recent M-class flare from AR3112 may produce a CME, awaiting coronal graph imagery for confirmation. Given it's location in the northwest, any CME could potentially be Earth-directed. Largely Quiet to Unsettled but with a risk of Active intervals late on day 1 or early on day 2 (11th or 12th) due to possible glancing CME effects and a slight chance of an isolated G1 Minor/Storm interval for the same period.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be at Background, but with a daily Slight Chance of rising in response to any large flares, primarily from AR3112 or AR3116 in the northwest disc. The high energy electron flux (greater than 2 MeV) is likely to persist at mainly Moderate to High levels. The associated electron fluence is forecast to persist at Active levels, but with confidence declining later in the period, especially if Earth does encounter glancing CME effects.

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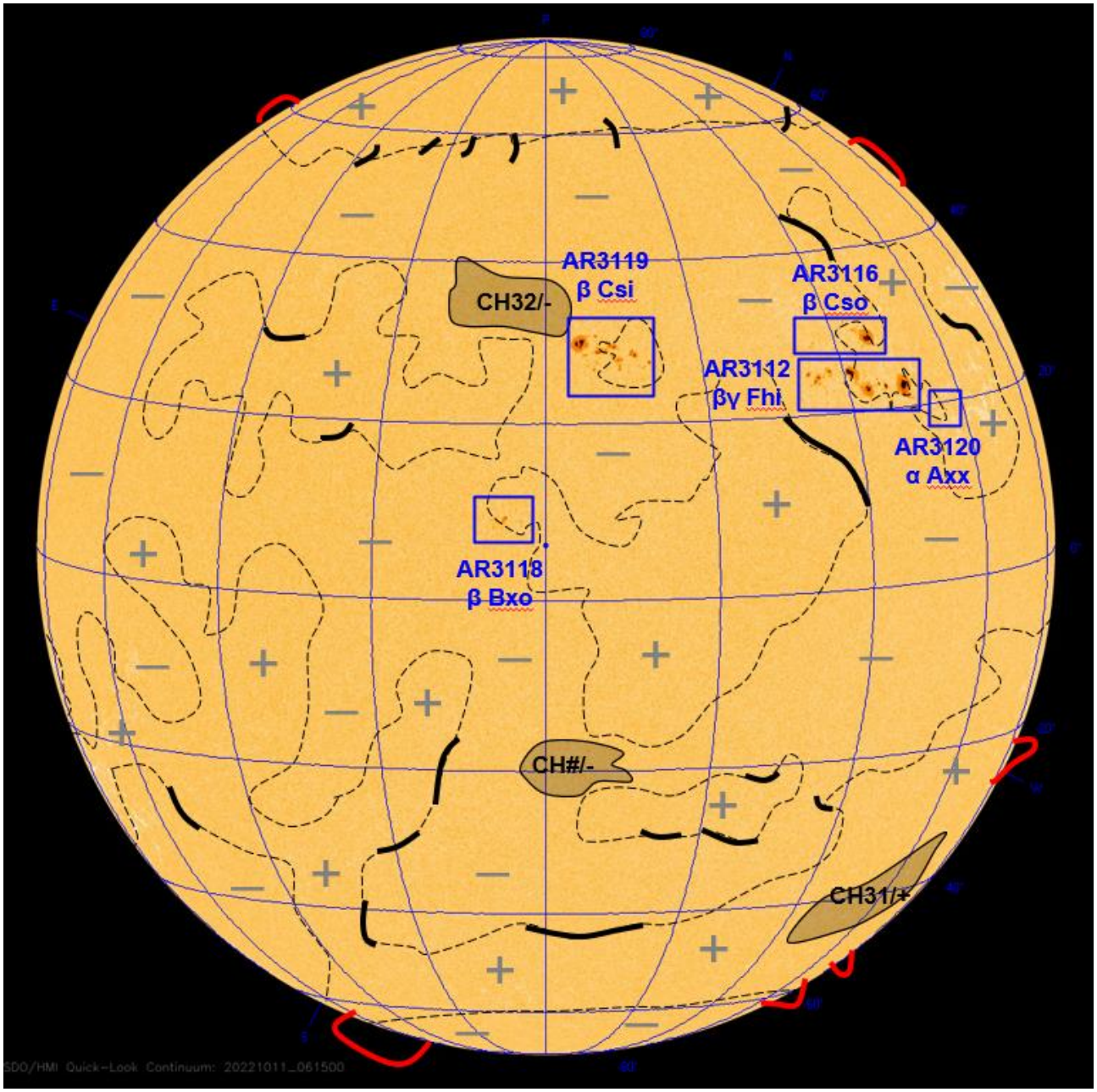
Figure 1. Solar Analysis Valid 11/0615 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no major Earth-directed CMEs in the forecast, however the 07/0730 UTC filament eruption CME may pass close to the Earth overnight UTC 11 into 12 October, giving some very slight peripheral influences. The 09/2300 UTC filament eruption from the southeast quadrant has been analysed as having the potential for an Earth directed component, with provisional assessment giving the risk of a glancing hit early on the 14th.

Otherwise, ongoing waning fast winds, most probably from CH29/+ and perhaps CH31/+, are likely to continue to gradually ease through day 1 (11th), likely approaching background day 2 (12th October). Some further enhancement is possible late on day 1 or early on day 2 (11th or 12th) due to possible glancing CME effects.

AR3112 produced an M3.9 flare at 11/0842 UTC, although awaiting coronal graph imagery for any potential CME, which could be Earth-directed.

Largely Quiet to Unsettled, but with a risk of Active intervals and a slight chance of G1 Minor geomagnetic storms late on day 1 or early on day 2 (11th or 12th Oct) in association with possible glancing CME impacts.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
07/1715 UTC	Partial	Filament Eruption	NW quadrant	370km/s	11/2359UTC +/- 8 hrs	Weak, low confidence, glancing blow.

Figure 2: MOSWOC Enlil – shows a possible glancing CME late on the 11th or early on the 12th October.

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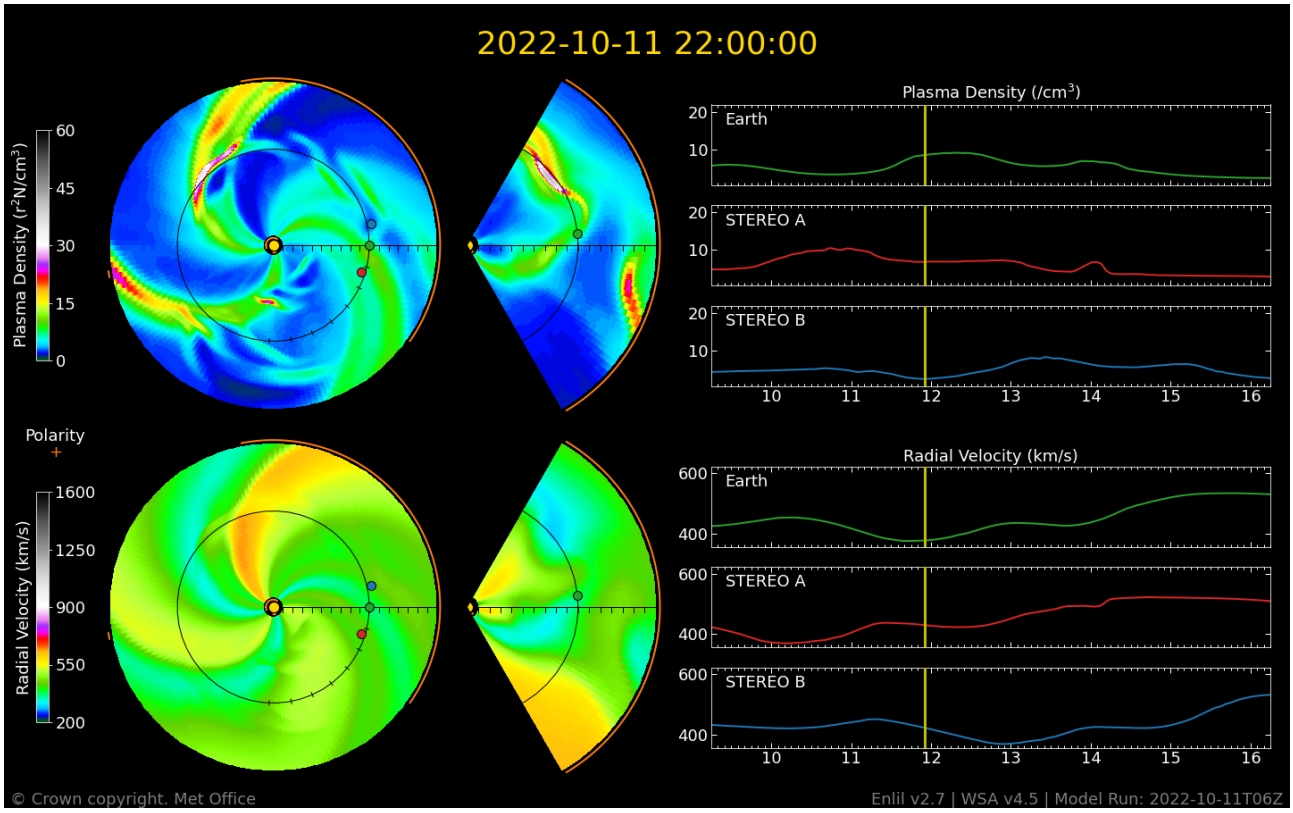

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Radio Blackouts - X-Ray Flares:
There are currently five numbered sunspot regions on the visible disc. AR3112 remains the largest and most complex group, classification Fhi/beta-gamma, which has recently produced M-class flares. Given the complexity of AR3112, there are likely to be further M-class flares from this region as it continues to rotate towards the northwest limb, with a slight chance (5%) of an X-class flare. All other remaining sunspot regions remain small and relatively stable. None of the sunspot regions currently on the visible are expected to rotate off disc in the coming days.

Far-side soundings suggest that there may be a succession of large regions due over the eastern solar horizon through the course of the coming 4 days, with this implying a possible increase in the risk of flares, although this will be confirmed as and when they present over the eastern limb for analysis.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES-16 X-Ray flux – shows recent M-class flares from AR3112.

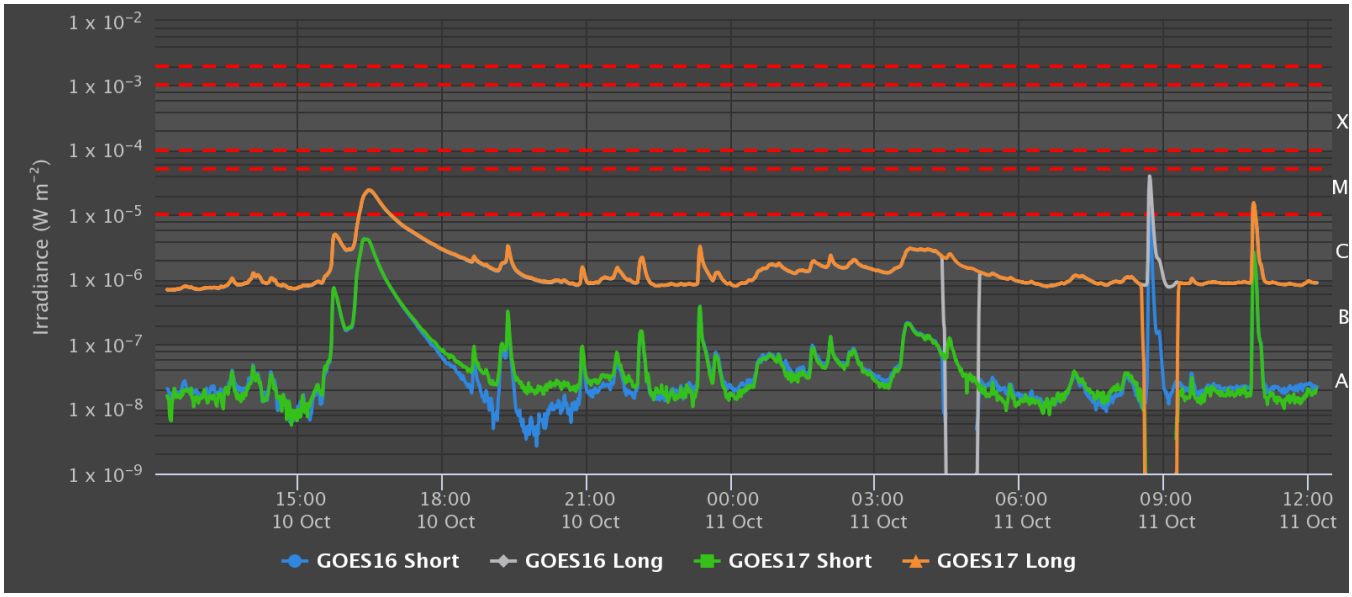

Figure 4: SDO/AIA 94 shows the M3.9 flare from AR3112.

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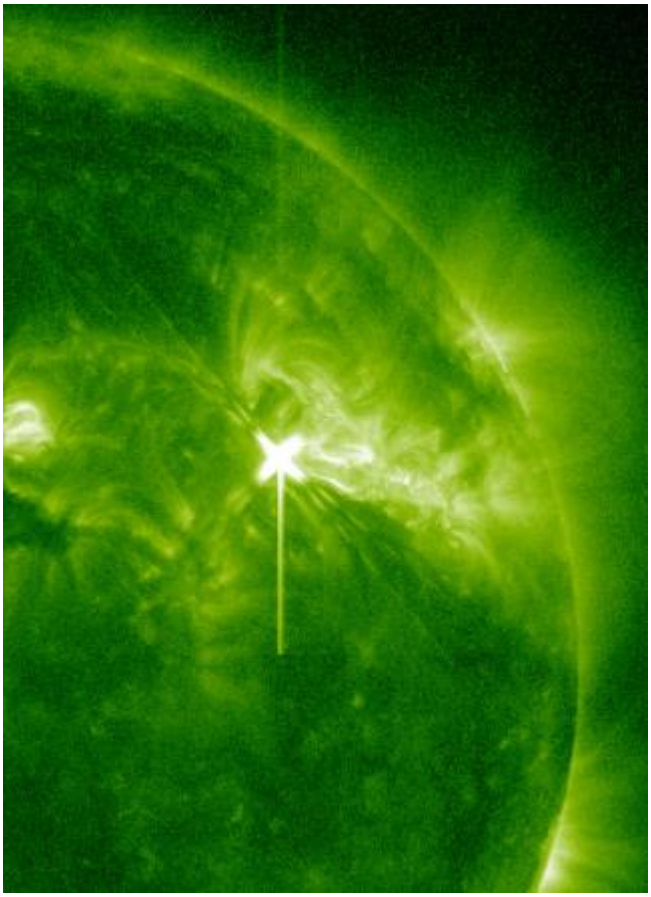

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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 is currently at Background levels.

We have seen a recent increase in flare activity from AR3112, with a peak M3.9 flare and also a M1.5 flare. Given there location, complexity and westward advance, there is a slight chance of seeing an S1 event. Any arriving eastern horizon regions are thought unlikely to contribute for some time yet to this risk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux as observed by GOES16 is currently High and is likely to range between Moderate and High through the coming days. Glancing CME effects are possible late on day 1 or early on day 2, which may give a reduction in flux however. Fluence is currently above Active (1e8 integrated pfu). Given that the threat of significant geomagnetic activity is greatest earlier on in the four-day forecast period, the chances of the current diurnal oscillation being disturbed or re-set at lower flux levels is highest late on day 1 or during day 2. Should this not occur, fluence is likely to remain Active, although with decreasing confidence in the coming days.

Overall, Active fluence is considered likely until day 4 (14th).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	80	60	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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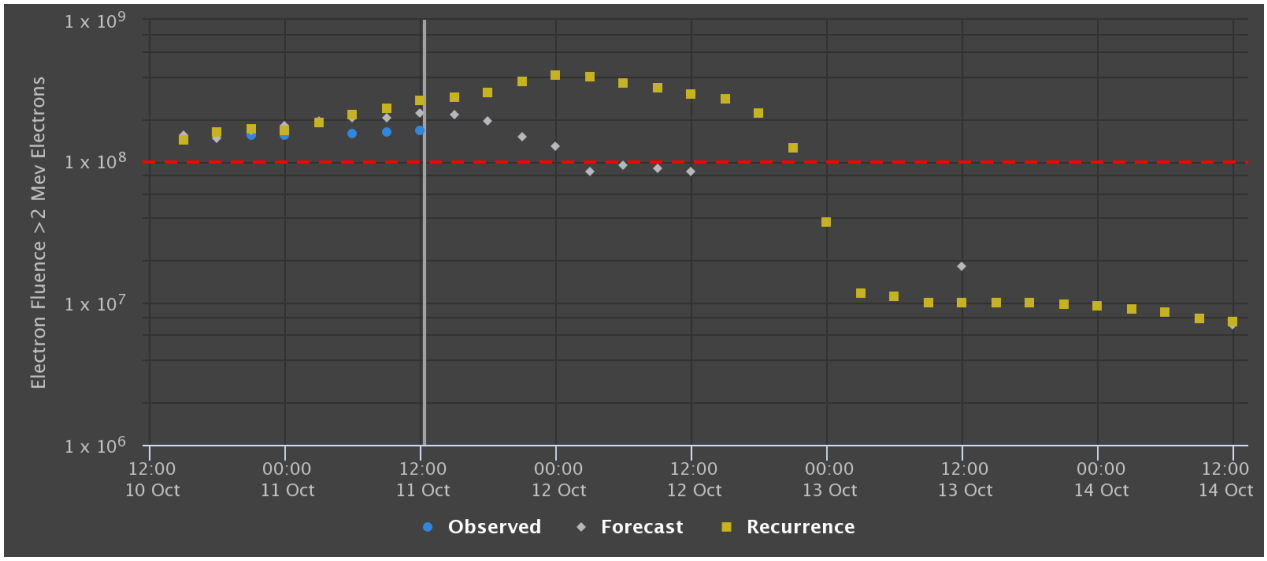
Figure 5: MOSWOC REFM electron fluence, observations and recurrence.



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